Agroforest Syst (2013) 87:849–856
DOI 10.1007/s10457-013-9601-5

Millwood honeylocust trees: seedpod nutritive value and yield characteristics

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Received: 1 September 2012 / Accepted: 17 February 2013 / Published online: 2 March 2013

Abstract The Millwood (MW) cultivar of the honeylocust (*Gleditsia triacanthos* L.) tree has gained particular interest for silvopasture systems due to the production of edible, high-sugar seedpods that livestock may consume after pod drop. Two studies were conducted within an active sheep and honeylocust silvopasture to (1) estimate nutritional variability of seedpods among MW trees, and to (2) determine seedpod yields and seasonal production variation of MW trees. Seedpods were harvested from each pod-bearing MW in October 2008 and 2009, just prior to pod drop. Nutritional characteristics such as detergent fibers, crude protein, in vitro digestibility, and sugar concentrations were determined for fractionated husk and seed components. Further, MW fodder yields were estimated in 2008, 2009, and 2010 through field measurements and tree yield classification. Both ground husks and seeds were low in fiber (273 and 132 g kg^{-1} neutral detergent fiber, respectively) and highly digestible (787 and 963 g kg^{-1}, respectively). Seed husk sugar concentrations averaged 223 g kg^{-1}. Based on the nutritive fractions assayed, whole ground MW seedpods grown in Virginia have a nutritional profile comparable to that of ground whole-ear dent corn (*Zea mays* L.) or oat (*Avena sativa* L.) grain. Nearly all MW trees displayed some form of alternate-bearing pattern. Average dry matter yields of pod-bearing trees were 15.8, 4.8, and 14.7 kg tree^{-1} in 2008, 2009, and 2010, respectively. Pod yield and quality indicate MW honeylocust trees have good potential as fodder-bearing trees in temperate silvopasture systems.

Keywords Silvopasture · Agroforestry · Supplemental feed · Fodder

Introduction

Selecting appropriate trees is important for optimizing ecological and financial returns of agroforestry systems. Honeylocust (*Gleditsia triacanthos* L.) has gained particular interest for silvopasture systems because of its relatively fast growth rate, as well as morphological and phenological characteristics that compliment cool-season grass production (Fowells 1965; Clason and Sharrow 2000). Furthermore, honeylocust trees produce edible seedpods that livestock can consume after pod drop (Wilson 1991). Silvopastoral systems that incorporate honeylocust may be

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designed as widely-spaced "fodder orchards" to supply pods. These pods can serve as a supplemental feed over the course of several months in autumn and winter when cool-season grass production is limited or negligible (Wilson 1991; Gold and Hanover 1993).

Improved honeylocust varieties, such as the 'Millwood' cultivar (MW), produce seedpods with high nutritive value and elevated non-structural carbohydrate levels relative to pods from wild honeylocust trees (Scanlon 1980). In addition, MW trees may produce high seedpod yields (Moore 1948; Papanastasis et al. 1999). However, data regarding the nutritive value and yield of seedpods of specific, improved varieties of honeylocust such as MW are limited, particularly for the southern Appalachian region of North America. Thus, two studies were conducted within an active sheep and honeylocust silvopasture to (1) estimate the nutritional value of seedpods among MW trees and to (2) determine seedpod yields and estimate seasonal production variation by tree. Our hypothesis was that an immature, limited-management MW-based silvopasture system could produce seedpods of sufficient yield and quality to provide financial benefit for land managers based on estimated feed value.

Methods and materials

Research site characterization

Research was conducted in the agroforestry research and demonstration plots at Virginia Tech's Kentland Farms (37°11′ N latitude, 80°35′ W longitude, 545 m elevation above sea level). Soils on the site are fine-textured, mixed mesic, Typic Hapludults and are described as well-drained with sloped topography ranging from 10 to 25 %. Soils are characterized by moderate permeability and available water capacity, as well as low organic matter and fertility. Generally, precipitation is evenly distributed throughout the year and the long-term average is 1,085 mm year^{-1} (Table 1). However, precipitation during the course of the growing season in 2008 was below average and the winter of 2009 was characterized by above average precipitation. During this study, temperatures from year to year were comparable.

Trees for this study were originally created by grafting MW scion wood to root stock grown from MW seeds. Year old MW grafts were planted into pastures as bare root trees in the spring of 1995. Spacings were 12.5-m within row × 12.5-m between row; wildtype honeylocust trees were planted at 2.5-m intervals between MW within rows. Wildtype trees were thinned from the stand in 2008, removing 40 % of all trees and leaving a 5-m × 12.5-m spacing within rows. This configuration and thinning scheme was designed to minimize the need for graft trees while also creating the shading environment desired for silvopastures during the establishment phase.

Pastures predominantly contained tall fescue (*Festuca arundinacea* Schreb.). Forage growth was suppressed the first year after planting in the tree rooting zone to allow trees to develop, and trees were protected with tubes and cages until 2009. In spring and summer of 2008, 2009, and 2010, pastures were rotationally stocked with sheep (*Ovis aries* L.) as part of a larger study comparing honeylocust and black walnut (*Juglans nigra* L) silvopastures with open pasture systems.

Sample selection and preparation

In October 2008, 2009, and 2010, just prior to pod drop, six randomly-sampled seedpods were harvested from each pod-bearing MW tree to determine the variability in pod nutritive value among trees. Upon retrieval from the field, whole seedpods were dried (48–72 h at 55 °C) then fractionated into seed and husk components. Both husk and seed fractions were ground in two stages, the first being with a Wiley mill to pass a 2-mm screen. The husk fraction was then ground again with an electric coffee mill, while seeds were ground with a cyclone mill to pass through a 1-mm screen. At both stages, husks were ground with dry ice to prevent liberated sugars from adhering to the mill chamber and blades.

Nutritive analysis

Sample neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), crude protein (CP), in vitro true digestibility (IVTD), total sugar, sucrose, glucose, and fructose concentrations were estimated using near infrared reflectance spectroscopy (Foss NIR System 6,500 m, Silver Spring, MD, USA). Samples were scanned with near infrared radiation from 400 to 2,500 nm, and log (1/reflectance) was recorded. A stepwise multiple regression

Table 1 Temperature and precipitation data for the 2008–2010 study period and long-term averages at Kentland Farm, Blacksburg, VA

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008												
T-Avg	0.3	3	6.7	11.6	15	20.9	21.2	19.7	18	10.2	4.4	3.3
T-Min	−14.6	−9	−6	−5	1.5	6.7	8.5	7.8	6.1	−5.5	−10.7	−12
T-Max	19.8	20.5	21.9	27.9	28.7	33.6	32.1	30.8	30.3	28.1	23.3	20.1
P-Sum	23.4	44.5	51.1	96.5	54.4	55.6	141.5	70.9	34	22.4	41.4	91.4
2009												
T-Avg	−1.1	2.1	6.2	11.5	16.4	20.9	20.2	21.4	17.4	11.3	7.4	0.4
T-Min	−19.7	−13.6	−13.3	−1.8	0.6	9.8	9.6	13.8	6.9	−3.3	−4.3	−12.3
T-Max	15.8	18.8	24.3	29.6	27.7	30.9	30.5	30.7	29.2	28.1	24.6	15.5
P-Sum	75.2	28.2	85.6	64.1	188.7	91.9	93.7	74.4	68.8	65	88.6	164.3
2010												
T-Avg	−1.8	−1.6	6.5	12.8	17.6	22.6	23.6	22.9	–	–	–	–
T-Min	−14.7	−16.4	−7.7	−2.1	−2.1	9.8	6.5	13.3	–	–	–	–
T-Max	14	16.9	22.9	30.2	30.1	33.4	35.4	35.2	–	–	–	–
P-Sum	98.6	54.9	65.3	33.5	63.2	36.8	61	87.6	–	–	–	–
Long-term average												
Temperature	2.2	2.9	7.5	12.7	17.8	21.9	24	23.3	20.1	13.9	8.1	3.3
Precipitation	79.5	78.2	98	83.6	101.3	93.7	109.5	105.2	88.9	85.3	81.5	80.8

T-Avg monthly average temperature (°C), *T-Min* monthly minimum temperature (°C), *T-Max* monthly maximum temperature (°C), *P-Sum* sum of monthly precipitation (mm)

equation was generated for each fractionated husk and seed constituent. Optimum equations were selected based on low standard errors of calibration and validation, and high coefficients of determination for calibration (r^2) and performance (r^2). These were derived by regressing predicted data against actual data using a subset of fractionated husk and seed samples. Samples for calibration subsets for each assay were selected by WIN ISI Winscan software (Infrasoft 1999), which presented a subset of samples to be analyzed using wet chemistry. The validation accuracy was evaluated with high values of one minus the variance ratio and low standard errors of cross validation (Table 2).

Table 2 Calibration and validation statistics for near infrared spectroscopy (NIRS) for determination of Millwood seedpod husk and seed nutritive value

Item	Calibration				Validation	
	n	Mean	R^2	SEC	1−VR	SECV
IVTD	75	0.7901	0.9828	0.0147	0.9701	0.0195
Sugar	41	0.2351	0.8756	0.8111	0.5597	1.5220
Sucrose	42	0.1290	0.7037	0.8876	0.5087	1.1443
Glucose	40	0.0637	0.8176	0.2384	0.5827	0.3658
Fructose	40	0.0401	0.8626	0.3812	0.7308	0.5342
NDF	72	0.2755	0.9934	0.0782	0.9854	0.0117
ADF	72	0.1871	0.9908	0.0727	0.9833	0.0980
ADL	47	0.0725	0.9230	0.0513	0.8536	0.0709
CP	74	0.0947	0.9973	0.0330	0.996	0.0402

IVTD in vitro true digestibility, *NDF* neutral detergent fiber, *ADF* acid detergent fiber, *ADL* acid detergent lignin, *CP* crude protein, *SEC* standard error of calibration, 1−*VR* 1 minus the variance ratio calculated in cross validation in modified partial least squares regression, *SECV* standard error of cross validation in modified partial least squares regression

Samples were analyzed for CP at the Virginia Tech Soil Fertility Lab. Total nitrogen (N) was determined by dry combustion using a Vario MAX CNS macro elemental analyzer (Elementar, Hanau, Germany) and CP was calculated as N × 6.25. Pod total sugar, as well as sucrose, glucose, and fructose fractions were determined following enzymatic microplate assay procedures described by Hendrix (1993). Neutral and acid detergent fiber concentrations and ADL concentration were determined sequentially using batch procedures of the ANKOM fiber analysis system (ANKOM

Technology 2011a, 2011b). Following the initial extraction with neutral detergent solution, ground seed samples removed from the fiber analyzer were gelatinous and had unexpectedly high and inconsistent NDF values. Under the advisement of ANKOM technical staff, seed samples were pretreated in two stages to remove excess lipids and proteins. Filter bags containing seed samples were first soaked for 60 min in acetone with hand agitation every 15 min. Filter bags were air dried and then soaked twice (sequentially) in 25 ml of 10 % protease solution (2.5 ml protease + 22.5 ml H_2O) at 60 °C for 30 min, while agitated at 150 rpm in an orbital shaking incubator. Samples were rinsed thoroughly with warm water prior to standard ANKOM fiber analysis procedures. All samples were analyzed in duplicate and analysis was repeated if the coefficient of variation between duplicates exceeded 3 %.

Husk and seed IVTD was determined following ANKOM procedures (ANKOM Technology 2005) with a Daisy batch incubator system (ANKOM; Macedon, NY). Analysis was repeated if the coefficient of variation between duplicates exceeded 4 % for IVTD. Ruminal fluid for the IVTD assay was collected from a non-lactating Holstein cow (*Bos taurus* L.) in October 2009 and 2010 housed at the Virginia Tech Dairy Center. The cow was handled in accord with Virginia Tech Institutional Animal Care and Use Committee (IACUC) protocol (NRC 2010) The cow was fed a standard diet of first-cut, mixed, cool-season grass hay ad libitum and 0.45 kg of cracked corn (*Zea mays* L.) (constituting less than 5 % of daily dry matter intake) at approximately 0700 h each day. Ruminal fluid was sampled at approximately 1,300 h.

Tree yield estimates

In October of 2008, 2009, and 2010, visual assessment was used to estimate seedpod yield from MW trees. Measures such as percent branches bearing pods, percent cover per branch and relative pod density were collected. Trees were ranked according to the following scoring system:

1 Low pod yield; ≤33 % pod cover in canopy
2 Medium pod yield; 34–66 % pod cover in canopy
3 High pod yield; ≥67 % pod cover in canopy

In October of 2010, average of field measurements from all three years were used to determine three representative trees from each scoring class (nine sample trees, total). All seedpods on each sample tree were harvested by shaking pods from trees prior to natural pod drop. Seedpods were then dried (120–168 h at 55 °C) and weighed. Estimates of pod yield for unsampled trees were based on the relationship between harvest weight from sampled trees and pod yield score (low, medium, and high). To characterize MW tree size, measurements of tree height and diameter at breast height (DBH) were recorded in August 2010.

Results

Seedpod nutritive value and variability among millwood trees

Nutritive value of MW husks was determined for seedpods grown in 2008 and 2009, but nutritive value measures for seeds were possible only in 2008. Seedpod yields in 2009 were relatively low and few of the harvested seedpods contained seed, and thus precluded analysis. In 2009, seeds constituted 3 % of total seedpod DM, in contrast to 2008, when seeds constituted 29 % of total seedpod DM. Further, seeds from the 2009 harvest generally were brittle, and diseased or undeveloped, or both.

Both ground husks and seeds were highly digestible (787 and 963 g kg^{-1}, respectively) (Table 3), although the range in digestibility was much greater for husks. The IVTD values for husks ranged from 649 to 874 g kg^{-1}, and seed IVTD ranged from 900 to 991 g kg^{-1}. Husk sugar concentrations averaged 223 g kg^{-1} and ranged from 118 to 300 g kg^{-1} (Table 3). Sugar fractions averaged 136, 64, 23 g kg^{-1} for husk sucrose, glucose, and fructose, respectively. Among reducing sugars, husk sucrose concentrations were most variable, ranging from 45 to 208 g kg^{-1} Average NDF, ADF, and ADL values for husk were generally low (averaging 273, 193, and 63 g kg^{-1}, respectively), but concentrations of each fraction varied more than twofold. However, few trees produced husks with high fiber and low digestibility. Seeds in 2008 contained 132 g kg^{-1} NDF, 75 g kg^{-1} ADF, and no measurable ADL. Seed NDF concentrations ranged from 68 to 160 g kg^{-1} and ADF concentrations ranged from 47 to 101 g kg^{-1}. Seeds had greater CP concentrations than husks; values for the two fractions averaged 204 and 62 g kg^{-1}, respectively. The range of CP values was 155–255 g kg^{-1} for seeds and 31–101 g kg^{-1} for husks. Estimated values for IVTD, NDF, ADF, ADL, and CP of whole seedpods (husks and seeds together) in 2008 were 833, 235, 161, 63, and 99 g kg^{-1} respectively. Although seeds were only 29 % of DM, they supplied 60 % of total CP within whole seedpods.

Millwood seedpod production

The 13- to 15-year-old MW trees averaged 7.4 (±1.4) m-height and 12.7 (±2.4) cm DBH. Of the 72 trees in the study, 61 (85 %), 13 (18 %), and 67 (93 %) produced seedpods in 2008, 2009, and 2010 respectively. Pod yields were the greatest in 2008, when the estimated average yield of pod-bearing trees was 15.8 kg tree^{-1} (Table 4). In 2009, when few trees produced pods, yields averaged 4.8 kg tree^{-1}. Trees in 2010 were largely classified as medium-yielding and yields averaged 14.7 kg tree^{-1}. Weak positive relationships existed between tree DBH and estimated seedpod yields during the two most productive years and r^2 for 2008 and 2010 were 0.26 and 0.56, respectively.

Table 3 Nutritive value of millwood honeylocust seedpod fractions

Item	Husk[a]	Seed[b]	Whole pods[c]
DM (%)	71.2 ± 7.6	28.8 ± 7.6	–
IVTD (g kg^{-1})	787 ± 50	963 ± 19	838 ± 134
NDF (g kg^{-1})	273 ± 53	132 ± 13	232 ± 31
ADF (g kg^{-1})	193 ± 40	75 ± 9	159 ± 20
ADL (g kg^{-1})	63 ± 15	–	45 ± 5
CP (g kg^{-1})	62 ± 17	204 ± 16	103 ± 20
Total (g kg^{-1})	223 ± 38	–	–
Sucrose (g kg^{-1})	136 ± 35	–	–
Glucose (g kg^{-1})	64 ± 3	–	–
Fructose (g kg^{-1})	23 ± 3	–	–

DM dry matter, *IVTD* in vitro true digestibility, *NDF* neutral detergent fiber, *ADF* acid detergent fiber, *CP* crude protein

[a] Husk data represent average of values from seedpods collected in 2008 and 2009

[b] Seed nutritive value data determined only with seeds collected in 2008. In 2009, seedpods did not contain enough seed material to conduct lab analyses

[c] Estimated from the mean of each analyte based on DM % for each fraction

Over three years, most pod-bearing trees (69 out of 72; 96 %) displayed some form of alternate bearing pattern. Based on pod scores, about half (32 trees) had relatively high yields in 2008 followed by relatively low yields in 2009 and moderate yields in 2010. Fourteen trees (28 % of 72 pod bearing trees) had two consecutive years of no production followed by one year of low to medium pod production. Only three trees produced comparable yields over all years, but yields were generally low (4.8 kg tree^{-1}).

Discussion

Nutritive variability of seedpods among millwood trees

Millwood husks and seeds have high digestibility and nutritive value and could be an excellent supplemental feed. The nutritional value of whole, ground MW seedpods in this study was comparable to that of ground whole-ear dent corn or oat grain (NRC 1989; Table 5). Animal performance trials from early extension station reports also support this comparison, as ground seedpods from Millwood trees were successfully substituted 1:1 for oats in dairy rations (Atkins 1942).

Average husk sugar concentrations in this study (223 g kg^{-1}) were lower than values reported in early studies (356 g kg^{-1}; Scanlon 1980). However, Detwiler (1947) observed that pod sugar concentrations varied geographically, despite the clonal nature of MW trees. Seedpods collected from MW trees grown in Beltsville, MD had 211 g kg^{-1} total sugar concentrations, while trees grown in Auburn, AL produced pods with concentrations as high as 368 g kg^{-1} (Detwiler 1947; Scanlon 1980). Millwood husks within this study had higher glucose fractions (64 g kg^{-1}) than those reported in early studies (33 g kg^{-1}; Scanlon 1980).

Husk NDF, ADF, and ADL concentrations were lower than those found by Papanastasis et al. (1999). Seed fiber values were also lower; however this may be due to differences in analytical methods. It is possible that those authors overestimated the fiber fractions, as they apparently did not use acetone and protease pre-treatments to liberate fats and proteins contained within seed samples.

Husk CP concentrations (62 g kg^{-1}) were generally low (Table 3) and comparable to values found in

Table 4 Millwood honeylocust seedpod yields from 72 sample trees

Yield score	Pod DM yield (kg tree^{-1})			Average pods (tree^{-1})	Number of trees		
	Average	Min	Max		2008	2009	2010
High	26.3	22.5	29.3	2240	25	0	8
Medium	15.8	11.7	19.0	1340	12	0	36
Low	4.8	3.3	5.8	410	24	13	23

Table 5 Conventional feeds with nutritive profile comparable to whole, ground millwood honeylocust seedpods

	NDF (g kg^{-1})	ADF (g kg^{-1})	ADL (g kg^{-1})	CP (g kg^{-1})
Ground Millwood seedpods	235	161	63	99
Ground whole-ear dent corn[a]	280	110	20	90
Oat grain[a]	320	160	30	133

[a] NRC (1989). Nutritional requirements of dairy cattle

early research (82 g kg^{-1}; Scanlon 1980). Papanastasis et al. (1999) reported Millwood trees grown in southern France produced pods with CP concentrations as high as 123 g kg^{-1}.

Seed CP concentration averaged 204 g kg^{-1} in this study. This was as much as 93 g kg^{-1} lower than values reported for MW seeds in other research (Scanlon 1980; Papanastasis et al. 1999). Seeds provided the majority of the CP found in whole MW seedpods. However, capacity to meet livestock CP needs with MW seedpods would be limited by low production years as in 2009. Johnson et al. (2012) found that ground MW seeds were nearly fivefold more digestible than whole seeds (204 vs. 965 g kg^{-1}). In grazing systems where livestock are expected to consume the pods directly, greater limits to using the seeds' nutrients would be expected without some form of processing. Although small ruminants have been found to digest honeylocust seeds in several studies (leRoux 1959b; Small 1983; Foroughbakhch et al. 2007), the digestibility range can be quite broad, and data on cattle performance with honeylocust pods do not exist to our knowledge. If one assumes only limited seed digestion, consuming whole pods would not meet a cow's maintenance requirements for CP (NRC 1989).

Millwood seedpod production

Nearly all MW trees displayed some form of alternate bearing pattern. Those few trees having similar yields from year to year had relatively low pod yields in all three years. Tree DBH was weakly correlated with seedpod yields during productive years. Honeylocust's irregular fruiting from year-to-year is a commonly occurring phenomenon in many fruit, nut, and mast producing trees. More well-known, economically and ecologically valuable tree species that display alternate bearing include oak, apple, pear, avacoado, walnut, citrus, and pistachio (Hodgson and Cameron 1935; Jonkers 1979; Dennis and Neilsen 1993; Crawley and Long 1995; Rosecrance et al. 1998; Maeto and Ozaki 2003). The exact cause of alternate bearing pattern is not known, but research suggests it may be the result of several species-specific and environmental factors (Jonkers 1979; Crawley and Long 1995; Rosecrance et al. 1998). Several strategies, such as pruning, girdling, fruit thinning, nutrient management, and breeding programs are utilized in fruit and nut orchards to adjust bearing patterns; however yield responses to these techniques are species-specific (Jonkers 1979; Davie et al. 1995). Past studies focusing on honeylocust pod yields, such as Moore (1948) and Papanastasis et al. (1999), show the tree's tendency to alternately bear; however there is no reported evidence concerning the genetic or environmental causes of such patterns.

Overall, yields were lower than those reported of 5- to 10-year-old trees by Moore (1948), where the 5-yr average yield was 32.9 kg tree^{-1} year^{-1}. However, it is not clear that Moore's figures are on a DM basis. It should be noted that branches of high yielding trees

Table 6 Estimated seedpod yields of 13- to 15-year-old Millwood honeylocust trees grown in Appalachian silvopastures

Tree spacing (m)	Trees (ha^{-1})	Estimated yield ($Mg\ ha^{-1}$)[a]		
		High-bearing year	Low bearing year	Three-year average
5 × 12.5	170	2.27	0.14	1.51
12.5 × 12.5	68	0.91	0.06	0.61

[a] High- and low-bearing years derived from estimated average yields per tree in 2008 (13.4 kg $tree^{-1}$) and 2009 (0.9 kg $tree^{-1}$). Three-year average (8.9 kg $tree^{-1}$) included 2010

within this study were densely covered by pod clusters and physically stressed under the weight. In 2010, scaffold branches of three high-bearing trees sagged and split under the weight of seedpods. Thus, it is unlikely that trees within this study could bear the yields reported by Moore (1948). In a production study conducted in Northern Greece, 8-year-old MW trees were found to produce over 1,000 pods $tree^{-1}$, with average dry matter yields weighing approximately 9.0 kg $tree^{-1}$ (Dini-Papanastasi 2004). In this study, yields averaged over all 72 study trees (including non-bearing trees), were 13.4, 0.9, and 12.3 kg $tree^{-1}$, for 2008, 2009, and 2010, respectively. A fodder orchard or silvopasture planted with 170 trees ha^{-1} and producing yields similar to those in this study would bear approximately 2.3 Mg ha^{-1} of pods (DM basis) in a productive year and 0.14 Mg ha^{-1} of pods in a low-yielding year (Table 6). Seedpod yields might be further improved through genetic selection, selective thinning, and more intensive management. Pruning strategy is one management factor that may have reduced yields in this study. Trees were managed to maintain a clear 2.4-m bole for future timber harvests. Although seedpod yields may be further improved by allowing canopies to have a more free-growth structure, this must be balanced with understory forage production needs.

Based on a 3-year average of 1.51 Mg ha^{-1}, and using an average value of oat grain at the time this research was conducted (2008–2009; $3.15 $bushel^{-1}$; USDA 2009), MW trees could generate over $325 ha^{-1} $year^{-1}$ in feed supplement equivalent. These estimates likely might be considered conservative given that our yield averages include non-bearing trees. However, any valorization must include the costs to grow and protect the trees and should include costs (if any) for harvest, processing, or storage. It is our intention to make this the subject of a future research paper.

Conclusion

Millwood seedpods have high digestibility and nutritive value and could be an excellent supplemental feed. Further, MW trees may produce sufficient yields of seedpods to provide financial benefit for land managers. While these trees have great potential for ruminant production in general and silvopasture systems specifically, valorizing this potential feed resource must include assessment of tree production costs and the potential impact of honeylocust trees on the forage system.

Acknowledgments The authors would like to thank the USDA's Southern Sustainable Agriculture Research and Education (SARE) Graduate Student Grant in Sustainable Agriculture program for their partial financial support of this research (Project # GS09-079). Thanks to all those who assisted with field and lab work, including James Mutunga, Norma Nelson, Spencer Shanholtz, Heather Taylor, Jerry Johnson, and Kathryn Sutton. Thanks to Jon Wooge and the crew at Kentland Farms for maintaining the agroforestry research site.

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